CA-T-1
Docket No. 03-0417

DIRECT TESTIMONY AND EXHIBITS

OF

MICHAEL E. KISER, P.E.

ON BEHALF OF

THE DIVISION OF CONSUMER ADVOCACY

SUBJECT: DETERMINATION OF THE NEED FOR, AND THE REASONABLENESS OF THE EOTP.

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DIRECT TESTIMONY OF MICHAEL E. KISER, P.E.

I. INTRODUCTION AND BACKGROUND.

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Michael E. Kiser. My business address is 708 Winterberry Drive, Findlay, Ohio 45840.

Q. IN WHAT CAPACITY ARE YOU EMPLOYED?

A. I am president of an independent consulting engineering firm operating under the name of MK Power Solutions, Inc.

Q. PLEASE DESCRIBE MK POWER SOLUTIONS, INC.

A. MK Power Solutions is a consulting firm serving clients on utility matters throughout the United States, primarily in the areas related to electric power system design, transmission arrangements, system planning studies, and regulatory matters.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?

A. I graduated in 1992 from the University of Toledo at Toledo, Ohio with a Bachelor of Science degree in Electrical Engineering.

Q. PLEASE STATE YOUR PROFESSIONAL EXPERIENCE.

A. From 1992 to 1994, I worked for Colonial Pipeline Company in Atlanta, Georgia. During this time, my responsibilities included the design, analysis and implementation of electrical distribution systems for petroleum pipeline pumping applications. In 1994, I began working for Caterpillar, Inc. in Lafayette, Indiana. At Caterpillar, Inc. I served as a project design engineer providing quotations, design and project management support for the application of natural gas and diesel engines for power generation, oil well servicing, cooling and other applications. In 1995, I accepted a consulting engineer position with Sawvel and Associates, an independent consulting firm in Findlay, Ohio. While working for Sawvel and Associates, I provided consulting services relative to electric system design, planning, power supply, rate and regulatory matters. On January 1, 2001, I founded MK Power Solutions, Inc., an independent consulting and engineering firm located in Findlay, Ohio. In this capacity, I continue to provide consulting services relative to utility systems, principally in the areas mentioned.

Q. ARE YOU A MEMBER OF ANY PROFESSIONAL ORGANIZATIONS?

A. Yes, I am a member of The Institute of Electrical and Electronics Engineers, Inc., and the Society of Power Engineers.

Q. ARE YOU REGISTERED TO PRACTICE AS A PROFESSIONAL ENGINEER?

A. Yes. I am registered as a Professional Engineer in the state of Ohio.

Q. HAVE YOU PREVIOUSLY PROVIDED EXPERT TESTIMONY REGARDING RATE MATTERS BEFORE ANY PUBLIC UTILITY SERVICE COMMISSION?

A. Yes. I have sponsored testimony before the Federal Energy Regulatory Commission, Kansas Corporation Commission, and the Public Utilities Commission of Ohio. My regulatory experience is set forth in CA-100.

Q. ON WHOSE BEHALF ARE YOU APPEARING IN THIS PROCEEDING?

A. I am appearing on behalf of the Division of Consumer Advocacy, hereinafter referred to as Consumer Advocate. MK Power Solutions has been retained by the Consumer Advocate to review and analyze matters relating to Hawaiian Electric Company, Inc.'s ("HECO" or "Company") East Oahu Transmission Project ("EOTP"), which is the subject of the instant proceeding.

Q. WHAT IS YOUR ROLE IN THIS PROCEEDING?

A. My role is to address each of the issues set forth in Order No. 20968 filed on May 10, 2004, by the Public Utilities Commission of the State of Hawaii ("PUC" or "Commission"), which are as follows:

1. Whether HECO's proposed expenditures for Phases 1 and 2 of the East Oahu Transmission Project will provide facilities which are reasonably required to meet HECO's present or future requirements for utility purposes?
2. Whether HECO's selected routing, location, configuration and method of construction for Phases 1 and 2 of the East Oahu Transmission Project are reasonable?
3. Whether HECO's East Oahu Transmission Project is preferable to HECO's other 138kV and 46kV transmission system alternatives, comparing factors such as, but not limited to the following:
   a. Cost;
   b. Timeliness and Schedule;
   c. Effectiveness;
   d. Construction impacts;
   e. Electromagnetic fields;
   f. Other impacts, if any;
   g. Pubic sentiment; and
   h. The public welfare in general.
4. Whether HECO's East Oahu Transmission Project is preferable to other feasible non-transmission options?
5. Pursuant to the requirements of HRS 269-27.6(a), whether all (as proposed by HECO) or part of the 46kV lines that are part of HECO's

East Oahu Transmission Project should be placed, constructed, erected or built below the surface of the ground?

Q. HOW IS YOUR TESTIMONY STRUCTURED?

A. To address the above issues, my testimony is divided into the following sections;

1. Project Background and Development.
2. Project Needs Assessment.
3. System Planning Processes and Criteria.
4. Analysis of Kamoku 46 kV Underground Alternative – Expanded.
5. Comparison of EOTP as Propsed Versus other 46 kV and 138 kV Alternatives.
6. Comparison of EOTP as Proposed Versus other Non-Transmission Alternatives.
7. Placement of 46 kV Facilities Underground.

Q. ARE YOU SPONSORING ANY EXHIBITS IN THIS PROCEEDING?

A. I am sponsoring Exhibits CA-100 through CA-114. Exhibit CA-100 is my professional resume. Exhibits CA-101 through CA-114 are related to the discussion contained in my testimony.

- CA-101 shows HECO's 138 kV transmission system throughout the Island of Oahu.

- CA-102 shows HECO's 46 kV sub-transmission system in the vicinity of the Pukele Substation.
- CA-103 provides a simplified representation of the different component functions of an electric system.
- CA-104 provides an example of a simple one-customer system.
- CA-105 provides an example depicting system reliability.
- CA-106 provides an example of system utilization.
- CA-107 summarizes utilization of existing 138 kV transmission lines, while CA-108 summarizes utilization of existing HECO transmission substations.
- CA-109 graphically depicts the Koolau/Pukele Overload Situation.
- CA-110 graphically depicts preventing the Koolau/Pukele Overload Situation at least through 2012.
- CA-111 graphically depicts the Downtown Overload Situation.
- CA-112 summarizes the utilization of transmission substations once the EOTP is implemented.
- CA-113 is a copy of an article from IEEE Spectrum magazine discussing the nature of blackouts.
- CA-114 is an appendix of electric system terms and concepts relevant to my testimony.

Q. WERE THESE EXHIBITS PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION?

A. Yes, they were.

Q. ARE THERE OTHER DETAILS REGARDING YOUR TESTIMONY YOU WOULD LIKE TO POINT OUT?

A. Yes, CA-114 includes an appendix of relevant concepts and terms utilized throughout my testimony. I would like to direct the attention of readers of my testimony to this exhibit since understanding these terms is important for purposes of my testimony.

II. CONCLUSIONS AND RECOMMENDATIONS

Q. PLEASE SUMMARIZE THE IMPORTANT CONCLUSIONS REACHED IN YOUR TESTIMONY.

A. Conclusions reached in my testimony that should be pointed out are:

1. HECO did not properly plan or apply proper planning criteria when pursuing the Kamoku-Pukele 138 kV Underground Alternative (via Waahila Ridge).
2. HECO's transmission system and transmission substation transformers have adequate capacity to supply projected HECO load through 2022.

3. System improvements are needed on the 46 kV subtransmission system to redistribute load amongst the transmission substations of Pukele, Archer and Kamoku, which will better utilize the HECO electric system.

4. The 46 kV improvements proposed in the instant docket are consistent with proper planning and utilization of the HECO electric system.

5. The EOTP as proposed is preferable to:

   a. other 138kV and 46 kV alternatives presented in this proceeding; and

   b. non-transmission alternatives presented in this proceeding.

6. Pursuant to the requirements of HRS 269-27.6(a), all except two short segments of the 46kV lines that are part of HECO's EOTP should be placed, constructed, erected or built below the surface of the ground.

7. The costs of the EOTP are reasonable in development but improperly include costs for 138 kV planning and for a138/46 kV 80 MVA transformer at the Archer Substation that is not necessary, and for portions of the 46 kV lines that should be constructed as overhead lines.

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.

A. My testimony recommends that the improvements proposed by HECO in the instant docket known as the EOTP be approved in part, with the following adjustments and conditions:

1. The estimated cost of the instant EOTP ranging from $55,644,000 to $60,910,000[1] should be reduced by $12 million (i.e., $43,644,000 to $48,910,000) to remove the costs incurred during the period from 1991 through June 2002 to plan, scope and receive public input, route selection, environmental review and CDUP processes for the initial 138kV EOTP proposal. The costs should also include any Allowance for Funds Used During Construction ("AFUDC") accruals that were made for the costs incurred to pursue the 138kV EOTP alternative. This recommendation is based on points in my testimony that show HECO should have been focusing on implementing 46 kV projects during that time period, consistent with their own planning criteria.

2. The EOTP project cost should be further reduced by $1.6 million (i.e., $42,044,000 to $47,310,000) to remove the costs for equipment proposed in the instant 46kV EOTP that is not necessary at this time. Specifically, the 138/46 kV, 80 MVA transformer proposed to be installed at the Archer Substation as part of Phase 2 of the Kamoku 46 kV Underground Alternative – Expanded is not presently necessary to provide the intended benefits of the project.

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[1] On December 18, 2003, HECO filed an application requesting Commission approval to, among other things, commit approximately $55,424,000 for Item Y48500, East Oahu Transmission Project, in accordance with paragraph 2.3.g.2 of the Commission's General Order No. 7, Standards of Electric Utility Service in the State of Hawaii ("proposed project"). Supplemental testimony adjusted this figure to a range of $55,644,000 to $60,910,000 to include the costs associated with routing changes and possible additional street paving. (HECO ST-9, page 7).

3. The project cost should be reduced by $408,000 for certain proposed underground 46 kV segments, namely, the Pumehana Street to Date Street and Winam Avenue to Mooheau Avenue segments, which could be constructed as overhead segments, pursuant to HRS § 269-27.6(a).

4. When new transmission projects are pursued by HECO, the Company should be required to first demonstrate that appropriate distribution and sub-transmission projects have been implemented on a "best efforts" basis to fully utilize existing infrastructure.

5. HECO should be required to include the impacts of transmission and sub-transmission projects upon supply-side planning, consistent with HECO transmission planning criteria as a separate and distinct element of the IRP process.

The reasons for my support of the instant project are not, however, for the reasons stated by HECO as will be discussed in Section IV, (Project Needs Assessment) of my testimony.

III. PROJECT BACKGROUND AND DEVELOPMENT

Q. WHAT IS THE EOTP?

A. In brief, the EOTP is a project that is intended to provide a means by which HECO can reliably transmit energy to customers in East Oahu through improvements to the Company's electrical system. The initial plan was intended to improve the Company's transmission system by constructing a

138 kV underground and partial overhead (through Waahila Ridge) transmission line from the Pukele Substation to the Kamoku Substation. As will be discussed below, the initial proposal has since been significantly revised from a 138kV transmission line project to a two phase, 46 kV sub-transmission project.

Q. WHEN WAS THE NEED FOR THE EOTP DETERMINED?

A. As noted by Mr. Wong in HECO T-2, page 11, the need for the EOTP was determined in 1991 and supported by a study entitled the *East Oahu 138 kV Requirements* (HECO, July 1991), which was updated in August 1992. The *East Oahu 138 kV Requirements Updated* identified four system concerns as follows:

1. Transmission line overload of the lines feeding the combined Koolau and Pukele service areas (i.e., The Koolau/Pukele Overload Situation).
2. Transmission line overloading for the lines feeding the Downtown area (i.e., The Downtown Overload Situation).
3. Reliability of the Pukele Substation since it was fed by only two 138 kV transmission lines (i.e., The Pukele Substation Reliability Concern).
4. The need for adequate 138 kV lines to transmit power to the proposed new Kewalo and Kamoku Substations (i.e., The Downtown Substation Reliability Concern).

Q. WHY IS IT IMPORTANT FOR HECO TO ADDRESS THE ABOVE FOUR TRANSMISSION SYSTEM ISSUES?

A. The generation of energy needed to serve HECO's customers is produced by facilities located in West Oahu. In order to serve all of HECO's customers, the energy must be transmitted from the generation source in West Oahu over the electrical system consisting of transmission and distribution facilities covering the entire island of Oahu. If the facilities are unable to transmit the power, customers will not be able to receive the electrical energy necessary to meet their demands.

Q. WHAT WERE THE RECOMMENDATIONS OF THE 1991 AND 1992 *EAST OAHU REQUIREMENTS STUDIES* TO ADDRESS THE IDENTIFIED TRANSMISSION SYSTEM CONSTRAINTS?

A. The studies recommended the installation of a 138 kV underground line between the Archer Substation and Pukele Substation via the proposed new Kewalo and Kamoku Substations and a new underground/overhead 138 kV line between the Halawa and School Street Substations.

To comply with these recommendations, HECO pursued the following three separate projects:

1. the Kewalo 138-25 kV Transformer A&B project (Docket No. 7526);
2. the Kewalo-Kamoku 138 kV Transmission Line project (Docket No. 7602); and

3. the Kamoku-Pukele 138 kV Transmission Line project.

The first two projects were approved by the Commission[2] and have been completed. The third project, the Kamoku-Pukele 138 kV Transmission Line was abandoned after the June 2002, Board of Land and Natural Resources ("BLNR") denied HECO's application for a Conservation District Use Permit ("CDUP") to construct the overhead portions of that project on Waahia Ridge.

Various studies[3] from 1992 up until the BNLR denial of the CDUP in 2002 continued to recommend the Kamoku-Pukele 138 kV Underground Alternative as the preferred course of action to address the above transmission system concerns. Upon denial of the CDUP, HECO formed an Executive Team and solicited public input to identify and evaluate various alternatives. Results of this process identified three alternatives; 1) The Kamoku-Pukele 138 kV Underground Alternative (via Palolo), 2) the Kamoku 46 kV Underground Alternative, and 3) the Kamoku 46 kV Underground Alternative – Expanded. The Executive Team ultimately selected option 3, which is the project proposed in this docket.

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2 See Decision and Order Nos. 12616 and 12627, filed on September 23, 1993, and September 2, 1993, respectively.

3 The *Barbers Point to Downtown Undersea Cable Study* (HECO 1993), *Kamoku-Pukele 138-kV Transmission Line Alternatives Study* (CH2M HILL, June 1995), *Kamoku-Pukele 46 kV Alternatives Study* HECO 1994), *1998 East Oahu 138-kV Transmission Requirements Update Study* (HECO 1998), *May 1998 Kamoku-Pukele Transmission Line Project Draft EIS* and the *2000 Kamoku-Pukele Transmission Line Project Final EIS* all recommended the installation of the Kamoku-Pukele 138 kV transmission line project.

Q. IS THE PROPOSED EOTP NOW A TRANSMISSION PROJECT OR A SUB-TRANSMISSION PROJECT?

A. The name "East Oahu Transmission Project" implies that transmission facilities will be constructed. It is important to recognize, however, that HECO is pursuing the installation of 46 kV sub-transmission facilities in this docket. Thus, although the Kamoku 46 kV Underground Alternative – Expanded accomplishes many of the same goals as the originally pursued Kamoku-Pukele 138 kV Underground Alternative, the two projects are not equal, or replacements for one another.

Q. HOW DOES HECO DEFINE THE TRANSMISSION SYSTEM?

A. HECO defines the transmission system in Section V, Subsection D, and Part II of their transmission planning criteria. In this section, the transmission system is defined as all 138 kV lines, substation components, etc, and certain specific 46 kV facilities listed in the document.

Q. WILL HECO CONSIDER THE 46 KV IMPROVEMENTS INCLUDED IN THE KAMOKU 46 KV UNDERGROUND ALTERNATIVE – EXPANDED AS TRANSMISSION OR DISTRIBUTION FACILITIES?

A. HECO's response to CA-IR-27, part a states:

> The scope of the project includes work on both transmission and distribution equipment. Cost related to transmission work (i.e., the 46kV underground lines and the transformer installations at the Kamoku and Archer Substations) will be

> classified as transmission and cost related to distribution (i.e., modifications at existing distribution substations) will be classified as distribution.

Therefore, certain 46 kV facilities, namely the new underground 46 kV lines and the 138/46 kV transformers will be treated as transmission facilities by HECO, at least on a cost basis.

Q. WHAT IMPACT DOES HECO'S CONSIDERATION OF PORTIONS OF THE KAMOKU 46 KV UNDERGROUND ALTERNATIVE-EXPANDED AS TRANSMISSION FACILITIES HAVE UPON THE PROJECT BEING CONSIDERED A TRANSMISSION SYSTEM IMPROVEMENT?

A. No real impact. Improvements at the 138 kV level are simply different than improvements at the 46 kV sub-transmission level. 138 kV transmission lines typically operate in a looped or networked fashion, whereas 46 kV lines operate in a radial configuration. Protective relaying for 138 kV lines is designed completely different from relaying for 46 kV lines. 138 kV lines do not operate with automatic transfer switches and usually have redundant sources to avoid loss of load, whereas 46 kV radial lines rely on other 46 kV circuits for backup with auto transfer switches. Simply calling a piece of 46 kV equipment a transmission component does not mean it is truly treated as such. For example, HECO states that it will treat certain elements of the Kamoku 46 kV Underground Alternative-Expanded as transmission components in response to CA-IR-27, part a. In response to part b of the

same information request, HECO states, "Transmission loss calculations include transmission line losses resulting from the generator step-up transformers and losses that occur on the 138kV transmission system. Sub-transmission and distribution losses are not included." While defining certain 46 kV elements as transmission components may indicate that they are significant in some way, it can cause confusion as to what is really considered the transmission system and what is really a transmission system project.

Q. DO YOU CONSIDER THE KAMOKU 46 KV UNDERGROUND ALTERNATIVE – EXPANDED TO BE A "TRANSMISSION" PROJECT?

A. No. The primary focus of the project is to install 46 kV sub-transmission circuits from Archer and Kamoku to points where load can be transferred from Pukele to these new circuits, thus allowing the Pukele circuits to have backup from other 138 kV transmission substations. While the project helps alleviate some transmission system issues, it is not a transmission project. Those transmission system benefits derived from the project are a consequence of installing 46 kV facilities consistent with proper planning.

Q. WHAT IS THE IMPORTANT POINT OF THIS DISCUSSION REGARDING THE DEFINITION OF THIS PROJECT?

A. The important point to make here, which will be supported by my testimony is that system planning and implementation needs to not only consider transmission options, but must encompass a complete system planning process to achieve the best results. The EOTP project as proposed improves the reliability of HECO's electrical system and better utilizes the 46 kV system. This, in turn, improves the reliability of the transmission system and resolved several system issues. Electric systems are very capital intensive, therefore effective utilization of the infrastructure is critical to achieving the objective of providing reliable service at a reasonable cost. The need for system improvements must be appropriately demonstrated and weighed against all known solutions while fully utilizing the existing infrastructure of the electric system.

IV. ASSESSMENT OF THE PROJECT NEED

Q. HOW DID YOU ASSESS THE NEED FOR THE EOTP CONSISTENT WITH ISSUE NO. 1 OF COMMISSION ORDER NO. 20968?

A. The "Project Need" has been a debated subject throughout the history of the EOTP. Strong public opposition exists to the EOTP and the focal point of this opposition is the question of project need. To accurately address the issues presented in Order No. 20968, this section of my testimony looks at the

fundamental need for the project, not specific to the EOTP as proposed or other previously proposed 138 kV or 46 kV alternatives. This section of testimony simply answers the question "Are system improvements needed and why?"

HECO has analyzed numerous 138 kV and 46 kV alternatives to address the impending need for the EOTP. Throughout the history of the project, HECO has consistently presented the previously identified four consistent transmission system constraints, or problems s the basis for the EOTP.

It is imperative to understand the basis for concluding that there are potential transmission system constraints to determine if a need for system improvements exists, and if the need is as great as presented by HECO. Therefore, to assess the project need I determined whether each of the four transmission constraints exists, consistent with proper planning procedures and planning criteria. The result is a determination as to whether the EOTP, as proposed, is an appropriate project in light of the issues set forth in Order No. 20968.

Q. WHAT WERE THE SPECIFIC STEPS TAKEN TO ASSESS THE NEED FOR SYSTEM IMPROVEMENTS ON HECO'S ELECTRIC SYSTEM?

A. I first reviewed the project from a technical perspective, including review of relevant studies, pertinent documents, HECO transmission, sub-transmission

and distribution planning criteria, and HECO supplied load flow cases. Relevant HECO load flow cases were then analyzed under system contingencies (i.e., various equipment outages) to determine the reasonableness of the representations made by HECO in direct testimony, and to identify electric system weaknesses and deficiencies.

Load flow cases to support my findings were then developed based on the information contained in HECO's direct testimony, responses to information requests and other study data. Once again the system was analyzed to review HECO's proposed EOTP and to investigate other options that could be considered to improve HECO's electric system. HECO's transmission and sub-transmission planning criteria and other important considerations were then utilized to determine the effectiveness of various improvements.

Q. WHAT STUDIES DID YOU REVIEW IN PREPARATION OF YOUR TESTIMONY?

A. Following is a list of documents and studies I reviewed for this proceeding:

1. Direct Testimony, Supplemental Direct Testimony, Reponses to Information Requests and Supplemental Information Requests in the instant Docket.
2. The transmission study entitled *East Oahu 138KV Requirements* (HECO, July 1991).

3. The updated version of the above study entitled *East Oahu 138kV Requirements Updated, August 1992* (referred to by HECO as *East Oahu 138kV Requirements Study)* and related load flow studies.

4. Docket No. 7526—HECO's application for Commission for approval to commit funds in excess of $500,000 for Item BT-467, the installation of the Kewalo A&B 30/40/50 MVA transformers.

5. Docket No. 7602—HECO's application for Commission approval to commit funds in excess of $500,000 for item BT-476 installation of Kewalo-Kamoku 138 kV transmission line.

6. The study entitled *Kamoku-Pukele 138 kV Transmission Line Alternatives Study* (CH2M HILL, June 1995, Updated April 2000).

7. The *Kamoku-Pukele 46 kV Alternatives Study* (HECO, August 1994).

8. The *Kamoku Substation Siting Study* (HECO, June 1994).

9. The *May 1998 Kamoku-Pukele Transmission Line Project Draft EIS* (referred to by HECO as May *1998 Draft EIS.)*

10. Comments and various correspondence pertaining to the May 1998 Draft EIS.

11. The March 1998 study entitled *East Oahu Transmission Requirements Update Study.*

12. The *2003 East Oahu Alternatives Study (December 2003)* and related load flow studies.

13. The *East Oahu Project: Option to the Koolau/Pukele Transmission Line Overload Problem (December 2003)* and related load flow studies.

14. The *May 1998 Kamoku-Pukele Transmission Line Project Draft EIS* (referred to by HECO as May *1998 Draft EIS)*.

15. The *2000 Kamoku-Pukele Transmission Line Project Final EIS* (Final EIS).

16. The *East Oahu Transmission Project 46kV Phase Project, Draft Environmental Assessment.*

17. The *East Oahu Transmission Project 46kV Phase Project, Final Environmental Assessment.*

Q. PLEASE EXPLAIN THE PURPOSE FOR REVIEWING THE ABOVE DOCUMENTS AS PART OF THIS PROCEEDING.

A. Items 2 – 5, 8 - 11, and 14 - 15 (collectively "138 kV Studies") were examined in relevance to the need for the Kamoku-Pukele 138 kV Underground Alternative. Items 7, 12, 16 and 17 (collectively "46 kV Studies") were reviewed in relevance to 46 kV alternatives related to this docket. Finally, Items 6,13 and other documents (collectively "Non-Transmission Alternative Studies") were reviewed in relation to the EOTP compared to other non-transmission line alternatives.

Q. PLEASE EXPLAIN THE PURPOSE OF PERFORMING A LOAD FLOW ANALYSIS AND WHY SUCH ANALYSIS WAS PERFORMED TO DETERMINE THE NEED FOR THE INSTANT EOTP?

A. Load flow analysis is one of the most important tools that electric system planners utilize when assessing system performance and needed improvements. Load flow studies provide useful information to such as loading of lines and transformers, system performance under contingencies, impacts of various lines, transformers or other infrastructure additions (or retirements). Load flow studies are also utilized to test the system against planning criteria before and after various alternative system changes. The models include important system data as well as forecasted load data.

Q. FOR YOUR LOAD FLOW ANALYSIS, DID YOU ADJUST HECO'S SYSTEM LOAD DATA?

A. No, I utilized HECO's projected load data from the load flow models as submitted by HECO. The load data was from the August 2002 Long-Term Sales and Peak Forecast, base projections (HECO T-4, page 16).

Q. DID YOU ADJUST THE 2002 FORECASTED LOAD DATA TO REFLECT 2003 OR 2003 PROJECT LOADS?

A. No, for two reasons. First, HECO made certain adjustments to the load data (HECO T-4, page 20). Second, the system problems being studied are

long-term problems that are relatively unaffected by changes in forecasted load data for a year or two. Such changes do not change the problem being studied. A line overload in 2006 versus 2007 is still a line overload that occurs in the very near future.

Q. WHAT SOFTWARE PACKAGE DID YOU UTILIZE TO PERFORM YOUR LOAD FLOW ANALYSES?

A. I used the PowerWorld Simulator Version 11 ("PowerWorld").

Q. PLEASE DESCRIBE THE POWERWORLD SIMULATOR AND ITS CAPABILITIES.

A. PowerWorld is a full-featured power flow analysis software package capable of solving systems of up to 100,000 buses. It is completely compatible with Power Technologies International's ("PTI") Power System Simulator for Engineering (PSSE) Versions 23 through 29 and GE PSLF Version 11.1. PSSE is the program that HECO uses for load flow analysis.

PowerWorld utilizes a very comprehensive graphical editor including interactive, animated one-line diagrams that shows the flow of power in the system as flowing animations. Colored arrows on the transmission lines, loads, and generators are animated, with their movement, size, and direction proportional to the magnitude and direction of the power flow. This graphical data can be utilized to highlight system overloads or other concerns and

convey those points to non-technical audiences. Highlighted areas such as lines with red arrows can point out a line overload. Impacts of improvements can be seen immediately by clicking on various lines or other components to simulate what improvement is being considered. Impacts of this improvement on the overloaded line in this example are immediately seen graphically.

Q. HAVE YOU UTILIZED POWERWORLD FOR OTHER REGULATORY PROCEEDINGS?

A. Yes, I have used PowerWorld for transmission grid and generation analyses in proceedings before the Kansas Corporation Commission ("KCC"), the Public Utilities Commission of Ohio ("PUCO") and the Federal Energy Regulatory Commission ("FERC").

The case before the KCC was Docket No. 97-WSRE-676-MER, which related to the then proposed merger between Western Resources and Kansas City Power & Light. I represented a municipal utility, the Kansas City Board of Public Utilities in that proceeding. The KCC proceeding was paralleled with a FERC proceeding and the KCC took no action in the case.

The proceeding before the PUCO in which I utilized PowerWorld was Case No. 98-1636-EL-UNC in which FirstEnergy sold some generation facilities. The model was used to perform transmission analysis in order to determine the impact on voltage support from these facilities. PUCO

approved this sale with some proposed conditions that we requested on behalf of the Industrial Energy Users of Ohio.

I also utilized PowerWorld in two proceedings with FERC. The first case was the above referenced Western Resources Merger, FERC Docket No. EC97-56-000. Regional transmission constraints were reviewed and presented to FERC. My testimony was successful in delaying the merger and the merger was eventually called off mainly for financial reasons. The second FERC case, in which I utilized PowerWorld was Docket No. EC97-414-000, which was the FirstEnergy merger. My role was to provide supporting analysis to show the negative impacts upon transmission interconnections on behalf of the Industrial Users of Ohio ("IEU"). FirstEnergy did complete the merger with some conditions proposed by IEU.

Q. WAS POWERWORLD ACCEPTED BY THESE COMMISSIONS AS AN EFFECTIVE TOOL FOR MODELING ELECTRIC SYSTEMS?

A. Yes, in addition, both the KCC and FERC are licensed users of PowerWorld. According to PowerWorld Corporation, numerous regulatory commissions are, or have been licensed users of the software, including the U.S. Dept. of Justice, Antitrust Division, California Energy Commission, U.S. Department of

Energy, Federal Trade Commission, and the North American Electric Reliability Council.[4]

Q. WHAT SPECIFIC LOAD FLOW CASES DID YOU REVIEW?

A. I read (opened with PowerWorld) all cases supplied by HECO in PTI RAW format in response to CA-IR-11. This simply means that HECO provided load flow cases in PTI format, and PowerWorld was used to open the cases and verify that the cases did not have corrupted data and had reasonable results (reasonable mathematical results). In all, there are 263 cases that I reviewed utilizing PowerWorld. These cases are from the *2003 East Oahu Alternatives Study (December 2003),* the *2003 East Oahu Alternatives Study (December 2003)*, and the *East Oahu Project: Option to the Koolau/Pukele Transmission Line Overload Problem (December 2003)* provided by HECO.

Q. WHAT ANALYSES OF THESE CASES DID YOU PERFORM ON THESE VARIOUS LOAD FLOW CASES?

A. Using PowerWorld, I first independently confirmed HECO's representations regarding the need for the EOTP project to address transmission constraints. Results of the load flow cases solved in PowerWorld were compared to the solved cases provided by HECO in PTI raw format. Next, I reviewed 46 kV

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[4] Source : PowerWorld Corporation, May 25, 2005 email from Mark Laufenburg, President of PowerWorld corporation.

system-switching diagrams supplied by HECO in response to CA-IR-15, part c, to identify if any existing relief of these problems exists at this time. Based on this review, new load flow cases were developed to confirm my findings that there are existing facilities that can be utilized to relieve the system constraints. Next, contingency and voltage sensitivity analysis was performed on these newly developed cases. This was done to identify any potential low voltage situations and to determine if system changes created new problems. The results of these analyses were used to assess the validity of HECO's concerns for pursuing the EOTP.

A. KOOLAU/PUKELE OVERLOAD SITUATION

Q. ONE OF HECO'S REASONS FOR THE EOTP (138 KV or 46 KV) IS TO ADDRESS "THE KOOLAU/PUKELE OVERLOAD SITUATION." DO YOU AGREE THAT THE KOOLAU/PUKELE OVERLOAD SITUATION IS A REAL PROBLEM?

A. It is true that when both of the Waiau to Koolau 138 kV transmission lines are out of service, the Halawa to Ko'olau line does begin to exceed its emergency rating of 392 MW during this double contingency case based upon current load distributions at the HECO substations. However, if only one of the two Waiau to Koolau 138 kV lines and the Halawa to Ko'olau 138 kV line is out of service at the same time, the line rating is not exceeded on the remaining Waiau to Koolau 138 kV line. In other words, for the Koolau/Pukele Overload

Situation to occur, there has to be a double contingency outage and it has to be a specific combination, namely the two Waiau to Koolau lines must be out of service at the same time. In addition, it must be assumed that these two lines are out of service, and that HECO would not take measures to transfer load from the Pukele or Koolau Substations to prevent this overload.

As will be shown, it appears that the Koolau/Pukele Overload Situation exists if no action is taken, although HECO may have overstated the problem since there are available means to defer or eliminate this problem at least through 2012.

Q. WHAT IS THE CONSEQUENCE OF LINE OVERLOADING IN THE CASE OF THE KOOLAU/PUKELE OVERLOAD SITUATION?

A. If the two Waiau to Koolau 138 kV lines are out of service, and the Halawa Koolau line is overloaded, the consequences might range from load being shed from the Koolau/Pukele Substations, to complete failure of the aluminum conductors on the Halawa-Koolau transmission structures. The later consequence could result in lengthy outages until one or both of the Waiau to Koolau 138 kV lines is placed back into service.

Q. DO YOU AGREE WITH HECO'S CLAIM (HECO T-4, PAGE 21) THAT THE PUKELE OVERLOAD SITUATION VIOLATES HECO'S TRANSMISSION LINE PLANNING CRITERIA?

A. The reasonableness of this criteria will be reviewed in the next section of my testimony (Section V). However, assuming this criteria is appropriate, my review of the HECO load flow studies does not show overloading of the 138kV Halawa-Koolau transmission line in 2005 as HECO claims. Rather, my analysis demonstrates that the overloading will occur in 2007 if nothing is done at this time. The new load data, or assumptions presented in the 2003 Study as to the overload percentage (i.e., 100% versus 101%) could account for this minor difference in findings. If the load flow studies from the *2003 East Oahu Alternatives Study (December 2003)* are utilized, HECO's load flow studies do show a violation of transmission planning criteria beginning in 2007. In addition, I utilized the 2003 Study cases since they are the most recent cases provided by HECO.

Even though these load flow cases show a violation of Section IV.3 of HECO's Transmission Planning Criteria in 2007, it should be noted that the violation assumes an n-2 contingency, and that no load is transferred from the Pukele or Koolau Substations. In other words, for this overload to occur, one has to assume that the system is operated status quo regardless of what actions can be taken to avoid this situation. Load flows are, after all, mathematical models of the system. It is up to the user of the load flows to

determine how to present this data, and if measures can be taken to avoid the problem with the existing system.

Nevertheless, assuming that these two specific 138 kV lines from Waiau to Koolau Substations are out of service, and that nothing is done to utilize the existing facilities to move some load from the Koolau/Pukele Substations to other substations, overloading of the Halawa-Koolau 138 kV transmission line does occur in the load flow cases. It is highly unlikely that HECO would choose to not take corrective action to remedy the situation if an outage of any of the three 138kV transmission lines occurs.

Q. PLEASE SUMMARIZE WHEN OVERLOADS OCCUR AND TO WHAT EXTENT FOR THE KOOLAU/PUKELE OVERLOAD SITUATION (BASED ON HECO'S LOAD FLOWS AS SUBMITTED).

A. Load flow cases provided by HECO, specifically cases "base2007d.raw," "base2012da.raw," "base2017db.raw" and "base2022db.raw." represent the existing system in the years 2007, 2012, 2017 and 2022, respectively. These load flow cases were provided in response to CA-IR-11, part a and correspond to the *2003 East Oahu Alternatives Study (December 2003).*

Assuming that the two specific 138 kV lines from the Waiau to Koolau Substation are out of service, and that nothing is done to utilize existing facilities to move some load from the Koolau/Pukele Substations to other substations, the following line overloads occur in these cases:

Outage Description	Year of Overload	% Load of Remaining Line in Service
Waiau to Halawa Line 1 plus Waiau to Halawa Line 2	2007	101%
Waiau to Halawa Line 1 plus Halawa to Ko'olau Line	2012	100%
Waiau to Halawa Line 2 plus Halawa to Ko'olau Line	2012	100%

Please refer to CA-109 for a graphical depiction of these overload conditions. Red arrows and the red pie chart represent the direction of power flows on the transmission line that is overloaded and the relative overload (i.e., a red pie with 101% means the line is loaded at 101% of its emergency rating). As can be seen from the table above and CA-109, overloading does not occur for the two Waiau to Halawa 138 kV transmission lines until 2012, if HECO transfers load from the Koolau/Pukele Substations to other substations as discussed.

Q. ARE THERE MEASURES HECO CAN TAKE AT THIS TIME THAT COULD DEFER THESE OVERLOADS?

A. Yes, according to HECO T-4, page 38, 7% of the Pukele Substation load (13 MW) automatically transfers to the Archer Substation in the event that the Pukele Substation is out of service. There is no reason that this load cannot be moved to Archer at this time. Though this is not a large amount of load, it does help the situation.

Q. WHAT IMPACT DOES TRANSFERRING 13 MW OF LOAD FROM THE PUKELE SUBSTATION TO THE ARCHER SUBSTATION HAVE ON THE

HALAWA-KOOLAU 138 KV TRANSMISSION LINE OVERLOAD (A.K.A. THE KOOLAU/PUKELE OVERLOAD SITUATION)?

A. By modifying the HECO load flow cases "base2007d.raw," "base2012da.raw," "base2017db.raw" and "base2022db.raw" to reflect this transfer of load, the Halawa-Koolau lines do not begin to overload until after the year 2012. CA-110 graphically shows the Halawa-Koolau 138 kV line at 99% of emergency rating in 2012.

Q. ARE THERE OTHER THINGS HECO CAN DO BESIDES MOVING THIS 13 MW OF LOAD FROM THE PUKELE SUBSTATION TO THE ARCHER SUBSTATION, WHICH COULD FURTHER PREVENT OR DEFER THE HALAWA – KOOLAU 138 KV TRANSMISSION LINE FROM OVERLOADING?

A. Yes, in addition to transferring some load from the Pukele Substation to the Archer Substation as previously discussed, it appears that HECO could also prevent the Halawa to Koolau 138 kV transmission line from overloading during a double contingency outage by transferring some load from the Koolau Substation to the School Substation. HECO provided confidential switching diagrams of the 46 kV sub-transmission system in response to CA-IR-15, part c, pursuant to the terms of Protective Order No. 21850. These switching diagrams provide information regarding the 46 kV system configuration such as line ratings, tie points of circuits to other circuits, switch locations and

ratings, etc. Based on a review of these diagrams, it appears that HECO can move (by manual switching at this time) some Pukele and Koolau 46 kV loads to the existing Archer Substation and the School Street Substation. This "switching" requires manual reconfiguration of the 46 kV circuits by opening certain 46 kV switches and closing other 46 kV switches at various substations and along the lines.

This manual switching could become less tedious in the near future since HECO is installing a new energy management system (i.e., Docket No. 03-0360. If appropriate switches and equipment have the capability of being operated from the new energy management system, the task of manual switching could be streamlined to make the process of moving this load from Pukele and Koolau Substations to Archer and School Substations much simpler.

Q. WHAT ARE THE AMOUNTS OF LOADS THAT CAN BE SHIFTED FROM THE PUKELE AND KOOLAU SUBSTATIONS AT THIS TIME THAT COULD HELP WITH THE KOOLAU/PUKELE 138 KV TRANSMISSION LINE OVERLOAD SITUATION?

A. It is difficult to produce exact figures since these estimates were based upon a review of the 46 kV switching diagram. HECO's load flows did not model to this level of detail, and instead lumped load at the 46 kV level versus modeling the actual 46 kV lines and switches. It is, however, common practice to model

a line or network of lines feeding many customers as one single load. The customer loads fed from a 138/46 kV transformer are simply added together and modeled as one load. So changing the 46 kV system configuration by closing certain switches and opening others is not possible in the load flow model. However, at least one HECO load flow case, specifically, the "dp03_eotp45.raw" load flow case, which corresponds to the *2003 East Oahu Alternatives Study (December 2003)* contained some load data specific to certain distribution substations. This load data was utilized along with the 46 kV switching diagrams to determine which loads could be transferred from the Pukele Substation to the Archer Substation and from the Koolau Substation to School Street Substation.

It appears that three circuits from Archer (Archer 41, 42A and 46) can all tie to the Pukele circuits to serve some load. If each circuit is tied to the Pukele 46 kV circuits through switching, and each circuit picks up additional transformer loads from the McCully, Manoa and Ena Substations, roughly a minimum of 22 MW from Pukele can be shifted to the Archer Substation. An existing circuit from the School Substation (School-Nuuanu) ties to the Koolau-Nuuanu-Laelae circuit from the Koolau Substation. Loading of specific 46 kV substations served from the Koolau-Nuuanu-Laelae 46 kV circuit such as the Nuuanu 2, Hon Cel, Pali State Park were not available in the HECO supplied load flows since they are part of "lumped loads." Therefore, no transfer of load from the Koolau Substation to the School Street Substation

was assumed since such transfer would be based on speculation. Therefore, at a minimum, load transfer from the Pukele Substation should be approximately 22 MW using the above-described lines from Archer.

Q. PLEASE QUANTIFY THE EFFECTS OF TRANSFERRING APPROXIMATELY 22 MW OF LOAD FROM THE PUKELE SUBSTATION TO THE ARCHER SUBSTATION USING THE EXISTING 46 KV SYSTEMS.

A. By modifying the HECO load flow cases "base2007d.raw," "base2012da.raw," "base2017db.raw" and "base2022db.raw" to reflect this transfer of load, the Halawa-Koolau lines does not begin to overload until after the year 2012. Load flow studies indicate that overloading of the transmission lines feeding the Koolau/Pukele Substations can be deferred beyond 2012, if minimum loads are shifted from the Pukele/Koolau service area to the downtown service area. Both the transfer of 7% of the Pukele Substation load to the Archer Substation, and my analysis of switching diagrams indicate that this overload can be deferred until at least 2012. I am not certain if the two are cumulative though, since HECO does not identify the specific actions to transfer the 7% Pukele Substation Load to Archer Substations. It is possible that the deferral date could be further expanded into the future if the two are additive.

Q. WHEN YOU SAY THE LOAD IS "SWITCHED" FROM THE PUKELE/KOOLAU LOAD CENTERS, DO YOU MEAN THAT THE LOAD IS PERMANENTLY TRANSFERRED TO THE DOWNTOWN SERVICE AREA?

A. Not necessarily. Moving load from the Pukele and Koolau Substations to other substations does not have to be permanent. For example, when any of the 138 kV transmission lines feeding the Koolau or Pukele Substations are taken out of service for maintenance, load can be switched to other transmission lines and/or substations in order to reduce loading on the 138 kV lines feeding the Koolau or Pukele Substations in the event of a second forced outage.

Q. HAS THE COMPANY RECOGNIZED THE IMPORTANCE OF THE ABILITY TO TRANSFER LOAD FROM THE KOOLAU/PUKELE SUBSTATIONS TO THE DOWNTOWN SUBSTATION?

A. Not fully. The Company is making some minor system changes to be able to transfer some load from the Pukele Substation as noted in HECO T-4, page 44 and in response to CA-IR-11, pages 2 through 4. These minor changes consists of shifting:

- approximately 2 MW from Pukele to Archer by relocating the McCully Transformer #1 to the Waaialua Substation;
- 1.7 MW of load from Pukele Substation by relocating the McCully Transformer #3 to Makakilo Substation; and

- approximately, 5.75 MW of load to the Archer Substation from the Pukele Substation when the McCully #6 transformer was shifted to the 25 kV system.

However, as will be explained in my discussion of the Pukele Substation Reliability Concern (i.e., Section C. below), other significant 46 kV projects, which could have eliminated the Koolau/Pukele Overload Situation were not pursued by HECO.

Q. BESIDES TRANSFERRING LOAD FROM THE KOOLAU/PUKELE SUBSTATIONS TO THE DOWNTOWN SUBSTATIONS, ARE THERE OTHER MEASURES THAT COULD HELP DIMINISH THE KOOLAU TRANSMISSION LINE OVERLOADING?

A. Yes, demand side management ("DSM") and/or load management ("LM"), combined heat and power ("CHP") and distributed generation ("DG") can all help alleviate the Koolau/Pukele overload concern.

Q. WHAT IMPACT COULD PURSUING DSM, LM, CHP AND DG HAVE UPON THE KOOLAU/PUKELE OVERLOAD SITUATION?

A. The Koolau/Pukele Overload Situation could be completely addressed if these measures are properly implemented (HECO T-4, page 67). However, it should be noted that the timeframe for such measures is extremely long at this time compared to more immediate measures that may be needed, and the

costs of the DSM, LM, CHP, and DG measures are not completely determined at this time.

Q. BASED UPON THE ABILITY TO DEFER THE OVERLOAD OF THE KOOLAU/PUKELE TRANSMISSION LINES, IS THERE ANY CONCERN ABOUT THE KOOLAU/PUKELE OVERLOAD SITUATION?

A. I conclude that the potential for the Koolau/Pukele 138 kV transmission lines to be overloaded during the outage of two lines feeding the Koolau Substation, although real in 2012, is not as urgent as HECO claims. Simply having the ability to switch a significant amount of load (approximately 22 MW) from the Koolau/Pukele service area to the Archer and School Substations provides the flexibility to defer this problem until 2012 at a minimum. Further actions to pursue DSM/LM, CHP and DG will also help ease this concern.

Q. DO YOU CONCLUDE THAT THE KOOLAU/PUKELE OVERLOAD SITUATION SUPPORTS THE NEED FOR SYSTEM IMPROVEMENT ON HECO'S ELECTRIC SYSTEM?

A. Yes, although my analysis shows that the problem can be deferred with the existing electric system, it cannot be avoided. These deferral measures are relatively short term in nature (2012 by my conservative estimate) and long-term system improvements should be made to address this concern completely.

B. DOWNTOWN OVERLOAD SITUATION

Q. HECO ALSO CLAIMS THAT THE EOTP ADDRESSES A CONCERN REGARDING "THE DOWNTOWN OVERLOAD SITUATION." DO YOU AGREE?

A. Yes, potentially. The load flow cases I examined for 2022 show that the Makalapa-Airport 138 kV line reaches 98% of its rated capacity in 2022 during an outage of both the Halawa-School Street and Halawa-Iwilei 138 kV transmission lines. See CA-111 for a depiction of the system loading in the year 2022 for the downtown area.

I was, however, unable to confirm the assessment through 2023 because the load flow cases supplied by HECO do not contain data for the year 2023 or beyond. The downtown overload situation should not be dismissed since it is a possibility. The load flow cases provided show line loadings of 98% during double contingency outages.

Q. DOES IT APPEAR THAT THERE WOULD BE WAYS FOR HECO TO FURTHER DEFER THE DOWNTOWN OVERLOAD CONDITION BY SWITCHING LOADS FROM THE DOWNTOWN AREA TO OTHER SUBSTATIONS?

A. Yes, it appears that HECO has 46 kV ties from the Downtown Substation to the Pukele and Koolau Substations that could be utilized during maintenance periods to switch load from the Downtown Substation in order to further defer

the downtown overload that may occur in the years beyond 2022. This information was derived once again from the 46 kV switching diagrams provided by HECO in response to CA-IR-15, part c.

Q. DID YOU ESTIMATE THE AMOUNT OF LOAD THAT COULD BE SHIFTED FROM THE DOWNTOWN AREA TO OTHER SUBSTATIONS?

A. No, for two reasons. First, the load flow cases I examined were through the year 2022. The 2022 load flow cases would need to be extrapolated to create future years, which is impractical and may not be accurate. Second, these overload conditions are quite far into the future, so many factors can, and likely will, change between now and that time that will affect the results of any analysis done today.

Q. WHAT CONCERN, IF ANY, EXISTS AT THIS TIME ABOUT THE DOWNTOWN OVERLOAD?

A. The largest concern about the downtown overload condition is the uncertainty about the retirement of the Honolulu Power Plant ("HPP"). HECO does not have plans at this time to retire the HPP, but should future plans call for the retirement of the HPP, the downtown overload situation becomes a real concern.

I am aware that the Governor of state of Hawaii has formed a task force to work with stakeholders in developing the Honolulu waterfront and potentially

moving the HPP. While no decision has been made to-date, these efforts could involve the HPP site and impact the continued operation of the HPP.

Q. DO YOU CONCLUDE THAT THE DOWNTOWN OVERLOAD SITUATION SUPPORTS HECO'S NEED FOR THE EOTP?

A. Not fully at this time. I conclude that there is a possibility that this overloading could occur in the future (i.e., beyond 2022). However, the uncertainties of the continued operation of HPP are a factor that presently supports this concern. Having a system that is flexible and able to reliably serve customers in east Oahu, even if HPP is retired, should be a priority in system planning.

C. RELIABILITY OF THE ELECTRICAL SYSTEM SERVING THE PUKELE SUBSTATION

Q. AS SHOWN ABOVE, THE KOOLAU/PUKELE AND DOWNTOWN OVERLOAD CONCERNS ARE NOT CRITICAL AT THIS TIME. ANOTHER ISSUE RAISED BY HECO TO JUSTIFY THE NEED FOR THE EOTP IS "THE PUKELE SUBSTATION RELIABILITY CONCERN." IS THERE A CONCERN REGARDING THE RELIABILITY OF THE ELECTRICAL SYSTEM SERVING THE PUKELE SUBSTATION?

A. The issue at hand is the fact that the Pukele Substation has two 138 kV transmission sources following similar geographical routes. Further, much of the load fed from the Pukele Substation is not backed up by other substations through the Company's 46 kV or other distribution systems. Therefore, the

load fed from the Pukele Substation is vulnerable to interruption in the event that both 138 kV transmission lines feeding the Pukele Substation are out of service. As a result, there is some concern about the reliability of the electrical system feeding the Pukele Substation, just as there is concern about the reliability of many, if not all of the electrical systems feeding HECO's remaining substations on the island.

Q. IS THE RELIABILITY CONCERN REGARDING THE ELECTRICAL SYSTEM SERVING THE PUKELE SUBSTATION A PROBLEM THAT EXISTED PRIOR TO 1991?

A. Yes, the Pukele Substation was constructed in 1964 with two 138 kV feeds following the same route. Therefore, the reliability concern that Pukele Substation is fed from two similarly routed 138 kV sources existed prior to 1991.

Q. HAVE BOTH 138 KV LINES FEEDING PUKELE SUBSTATION EVER BEEN OUT OF SERVICE SIMULTANEOUSLY?

A. Yes, but only on one occasion, March 3, 2004. Prior to this date HECO had gone 40 years without an outage of both lines at the same time. A report entitled *HECO Report March 3, 2004 Pukele Substation Outage* was submitted to the Commission on May 11, 2004.

Q. WHAT CAUSED THE OUTAGE OF THE PUKELE SUBSTATION?

A. In simple terms, during scheduled maintenance of one of the two lines feeding the Pukele Substation, a communications system malfunctioned on the protection system and tripped the remaining 138 kV line out of service, referred to as a "forced outage."

Q. WHAT IS A FORCED OUTAGE?

A. A "forced outage" is the sudden or unexpected failure of a piece of equipment that was not planned to be taken out of service. This type of outage may, or may not result in loss of load depending upon whether or not there are other redundant components that can continue serving load.

Q. ARE FORCED OUTAGES A COMMON OCCURRENCE ON ELECTRIC SYSTEMS?

A. Yes, forced outages occur on all electric utility systems. Outages are an unfortunate consequence of operating an electric system. Human error, equipment malfunctions and natural events are the primary reasons for outages.

Q. WHAT ARE THE CONSEQUENCES OF FORCED OUTAGES ON ELECTRIC SYSTEMS?

A. Consequences of forced outages can range from equipment being out of service without loss of load to wide spread blackouts, or worst case, complete system blackouts. The March 3, 2004, outage of the Pukele Substation was a widespread outage. It is impressive, however, that only one such outage of this nature has occurred at the Pukele Substation.

Q. WITH THE IMPECCABLE FORCED OUTAGE RATING OF THE PUKELE SUBSTATION, DO YOU CONTEND THAT THERE IS STILL A CONCERN ABOUT THE RELIABILITY OF THE ELECTRICAL SYSTEM SERVING THE PUKELE SUBSTATION?

A. Yes, there is still some concern about the reliability of the systems serving the Pukele Substation since both 138 kV lines follow the same general route to the substation and the conductors are approximately 40 years old. However, the concern does not justify HECO's decision to **only** pursue 138 kV alternatives to address the situation. HECO should strengthen the 46 kV ties to the Pukele Substation to improve the reliability of the electrical system.

Q. DO YOU CONTRIBUTE THE RELIABILITY OF THE PUKELE SUBSTATION TO "GOOD FORTUNE" AS MENTIONED BY HECO?

A. I attribute the reliability of the Pukele Substation to proper maintenance and operations on the part of HECO to make the best efforts to keep this substation from having outages. The "good fortune" element in this case is simply that no major storms or other catastrophes have caused both lines to be out of service at the same time over the life of the transmission lines. Proper care and upgrades to structures are important to all electrical facilities and have paid off for HECO in the case of the lines feeding Pukele Substation.

Q. DOES HECO HAVE OTHER SUBSTATIONS (BESIDES PUKELE) SERVED WITH LESS THAN 138 KV THREE FEEDS?

A. Yes, the Airport, Archer, Kewalo, Kamoku and Wahiawa Substations all have less than three 138 kV feeds.

Q. DOES HECO HAVE THE SAME RELIABILITY CONCERNS ABOUT THESE FIVE SUBSTATIONS?

A. No, it appears not. In response to CA-IR-8, HECO stated:

> In general, the reliability of the Airport, Archer, Kamoku, Kewalo and Wahiawa Substations is important, although less of a concern than the reliability of the Pukele Substation, for the reasons such as the size of the load being served by the substation, the age of the facilities installed, the type of facilities installed (underground vs. overhead).

Q. WHAT AMOUNT OF LOAD WILL BE INTERRUPTED AT EACH SUBSTATION DURING THE LOSS OF THE TRANSMISSION LINES FEEDING PUKELE, AIRPORT, ARCHER, KAMOKU, KEWALO AND WAHIAWA SUBSTATIONS?

A. According to HECO, the following loads at each of the substations cannot be served during outages of both 138 kV feeds to the substations (or the single feed to Kamoku).

Pukele*	185 MW
Airport	3.5 MW
Archer	59.5 MW
Kamoku	5 MW
Kewalo	5 MW
Wahiawa	20 MW

These figures are adjusted from the 215 MVA HECO figure to reflect the ability to backup Pukele/Koolau loads from Archer as described above.

Q. DO YOU AGREE THAT RELIABILITY OF THE ELECTRICAL SYSTEM SHOULD FOCUS ON THE SIZE OF THE LOAD SERVED?

A. Yes, as a general statement, it applies to all system load. Loss of load is always an important consideration when planning any electric system. As pointed out earlier, it is imperative that the system survives during outages, but a system should be reasonably planned to serve load even under foreseeable and multiple contingencies. From a system planner's (transmission or distribution) perspective, the design of the system should consider load, but should also be impartial to factors such as location and economic status.

Q. WHAT FACTORS OTHER THAN LOAD SIZE SHOULD BE CONSIDERED?

A. Planners should also consider the type of customer served by the system and the impact an outage has on that customer. For example, a load considered critical could be a hospital, a military installment, or in the case of this docket, commercial loads located in the Waikiki. I note that the Archer Substation has approximately 47 MW of load that cannot be backed up from other substations during an outage of both Archer 138 kV lines. This load is classified as commercial load (see HECO's response to CA-IR-15, subpart d). The Kamoku and Kewalo Substation load is also classified as commercial load that cannot be backed up during an outage of both Archer 138 kV lines or both Kewalo Substation 138 kV lines. The Wahiawa Substation has approximately 2 MW of commercial loads that cannot be backed up during an outage of both 138 kV lines feeding the Wahiawa Substation.

It should be the goal of HECO's system planners to treat these loads with equality in terms of reliably serving the customers. While the Waikiki and remaining Pukele load is larger than the other load centers served by multiple 138kV lines that are not backed up by other systems, it is not necessarily more important than the downtown or other commercial centers served by these other substations on the island.

Thus, while of the six substations, the Pukele Substation is the greatest reliability concern due to age of the facilities and the fact that it is fed from two overhead transmission lines taking the same general route, this observation

does not discount the concerns regarding the reliability of the electrical system serving the other substations. As stated in HECO's response to subpart c of CA-IR-8; the Airport, Archer, Kamoku, Kewalo and Wahiawa Substations will all sustain loss of load when transmission sources feeding these substations are out of service.

Q. WITH THE EMPHASIS ON THE IMPORTANCE OF THE PUKELE LOAD, HAS HECO TAKEN STEPS TO IMPROVE THE RELIABILITY OF THE PUKELE SUBSTATION?

A. As pointed out earlier, HECO has done a great job of maintaining the 138 kV lines and equipment serving the Pukele Substation. HECO avoided an outage of both Pukele 138 kV lines simultaneously occurring for 40 years. Unfortunately, other steps besides 138 kV transmission improvements have not been taken and opportunities, such as utilizing the new Kewalo and Kamolu Substations to provide backup to the Pukele load through the sub transmission system by strengthening the 46 kV ties to Pukele have been missed.

Q. WHAT STEPS COULD HAVE BEEN TAKEN IN THE PAST TO INCREASE THE RELIABILITY OF THE PUKELE SUBSTATION?

A. HECO should have strengthened the 46 kV ties to other transmission substations because such efforts would allow HECO to transfer load, when

necessary to maintain the electrical system reliability. Constructing 46 kV improvements that better utilize the Archer Substation are not in place. Also, the Kewalo and Kamoku Substations were developed without 46 KV facilities, which could have served load right in the heart of the Pukele Substation load center. This is true before, and after the Company began pursuing the EOTP.

For example, tie circuits to Archer could have been constructed with capacity to backup a greater portion of the Pukele Substation. Projects to create ties to the School and/or Iwilei Substations could have also been pursued to allow backup of additional Pukele load. In recent years, the 138/46 kV transformers and 46 kV feeders from the Kamoku Substation could have been constructed as proposed in the instant docket.

Q. PLEASE EXPLAIN HOW THE DECISION TO DEVELOP THE KEWALO AND KAMOKU SUBSTATIONS WITHOUT 46 KV FACILITIES LIMITS THE USEFULNESS OF THE KEWALO AND KAMOKU SUBSTATIONS?

A. HECO's transmission system is 138 kV, which feeds 138 kV substations. At the 138 kV substations, transformers are installed to step voltage down to a sub-transmission voltage of 46 kV (and sometimes distribution voltages in special cases such as Kewalo and Kamoku Substations). From these transformers, 46 kV feeders emanate from the substations and feed multiple distribution substations which further step down the 46 kV voltage level to distribution voltages of 12kV and 4kV (a similar description of the system can

be found in HECO T-4, page 2). The Kewalo and Kamoku Substations were constructed with 138 kV stepped down to 25 kV transformers. The 25 kV feeders were constructed as distribution voltage and the step down of subtransmission of power at 46 kV was avoided. Consequently, the Kewalo and Kamoku feeders cannot be tied to any existing 46 kV circuits in the area, or any 12 kV or 4 kV circuits in the area. This essentially created a new 25 kV distribution island (as in independent) system that is only able to serve loads from these two substations. These two substations can back each other up, but the load is very small (approximately 10 MW) and they provide no meaningful and useful backup to loads in the area of the Pukele Substation.

Q. WHAT PROMPTED HECO TO SELECT 25 KV TRANSFORMATION IN LIEU OF CONSTRUCTING THE SUBSTATION IN A SIMILAR MANNER AS MOST OTHER HECO SUBSTATIONS?

A. At the time that the Kakaako Master Plan (Docket No. 7273) was developed, a very high load growth rate in the Kakaako area was anticipated by HECO. The Kakaako Master Plan called for the construction of the Keawe Substation to service 25 kV distribution load in the Kakaako area along with renovation of the Kamoku Substation to also serve 25 kV load. The plan recommended 25 kV as the distribution voltage of choice so that Keawe Substation could be constructed within height limitations, fewer 25 kV circuits could be constructed compared to 12 kV circuits, better voltage performance and capacity of 25 kV

circuits versus 12 kV and the overall cost was estimated to be less. (See page 20 of the *Kakaako Master Plan, June 1992).*

Q. WHAT IS THE CONCERN WITH THIS PLAN?

A. The study performed was too narrowly focused. Paragraph 2 of page 1 of the study, in summary states that the objective of the Kakaako Master Plan was to determine the maximum projected load in the Kakaako area, and to develop two plans for serving the load. Additionally, the study states that transmission and generation projects and load development schedules were beyond the scope of the study. These statements indicate that this study had a very narrow focus with pre-concluded objectives that did not include the possibility of other system benefits that could be gained from the plan.

Q. WHAT OTHER IMPORTANT FACTORS SHOULD HAVE BEEN INCLUDED IN THAT STUDY?

A. First, my opinion is that the study should have encompassed not only the maximum load growth, but the minimum as well, (which is basically the trend that has occurred for this area). Second, a planning study should not simply conclude that there are only two options to evaluate when other options may exist that have not been studied. Third, a distribution plan cannot be complete without consideration of transmission impacts, especially when the magnitudes of projected loads in the Kakaako Master Plan were so large.

Although it is easy to critique this study now that the Kakaako load growth did not occur as projected, but it is difficult to understand why such an important study was so narrow in focus. At the time the study was completed, the EOTP was also being studied and HECO was stating that the reliability of the Pukele Substation was a major concern. Thus, HECO could have, at that time, planned to develop these distribution substations with 46 kV circuits to backup the Pukele load.

Q. HECO STATES IN RESPONSE TO CA-IR-34, PART B, "AT THE TIME THE KEWALO AND KAMOKU SUBSTATIONS WERE BEING INSTALLED, HECO WAS PLANNING TO ULTIMATELY INSTALL A 138 KV TRANSMISSION LINE TO THE PUKELE SUBSTATION . . . THEREFORE, WOULD NOT REQUIRE THE EQUIPMENT PROPOSED FOR THE KAMOKU 46 KV UNDERGROUND ALTERNATIVE-EXPANDED PROJECT (I.E., 138/46 KV TRANSFORMERS AND CIRCUITS). DO YOU AGREE WITH THIS STATEMENT?

A. No. The best solution is to have multiple transmission sources and the ability for 46 kV and other distribution circuits to have a least one backup circuit, preferably from a substation fed by another transmission substation. HECO's sub-transmission standards and planning support this statement. In response to CA-IR-34, Part c, HECO states,

> Therefore, in order to follow the distribution criteria, which are used as a guideline to ensuring the reliability of the 46 kV

> sub-transmission systems, 46 kV circuits require the ability to automatically transfer to other circuits at the 46 kV substations . . . It is also preferred that the 46 kV circuits serving as back-up circuits (as a result of automatic transfers from one 46 kV circuit to the back-up) are served from a different transmission substation, where practical, without considering if there are two 138 kV feeds to the transmission substations that are serving the 46 kV substations. This provides added reliability to the 46 kV sub-transmission system if a problem should occur which affects the entire transmission substation (i.e. loss of 138 kV feeds to the transmission substation).

The above HECO statement conflicts with the idea that HECO should not pursue 46 kV projects because they were pursuing the 138 kV underground line from the Pukele to Kamoku Substations. Construction of the Kewalo and Kamoku Substations made it much more practical to install backup circuits to the Pukele 46 kV circuits, but such projects were not pursued. In addition, 46 kV capacity already existed at Archer Substation that could have been utilized at this time.

Q. COULD THE CONSUMER ADVOCATE HAVE RAISED THESE CONCERNS AT THE TIME THOSE TWO PROCEEDINGS (DOCKET NOS. 7526 AND 7602) WERE PROCESSED?

A. At the time of the proceedings, HECO had only presented one viable alternative, which was the Kamoku-Pukele 138 kV Underground Alternative (via Kewalo and Kamoku and the Waahila Ridge). Viable 46 kV alternatives were not presented for consideration until after the BNLR denied HECO's CDUP in 2002. This factor coupled with the then projected significant load

growth in the Kakaako district compelled the Consumer Advocate to not oppose these projects. It was not until after denial of the CDUP that the Consumer Advocate was made aware that other viable 46 kV alternatives existed at reasonable costs.

Q. AFTER THE KAKAAKO MASTER PLAN WAS COMPLETED, WHAT ACTIONS DID HECO TAKE TO IMPLEMENT THE PLAN?

A. HECO pursued projects at both the Kewalo and Kamoku Substations to install the 25 kV distribution systems as outlined in the Kakaako Master Plan. The first project pursued was the planned installation of two 138/25 kV 50 MVA transformers at Kewalo Substation as outlined in Docket No. 7526 (Kewalo A&B 30/40/50 MVA transformers) at a cost of $37,895,082. The second project was the installation of a 138 kV underground transmission line to the Kamoku Substation with associated substation equipment as outlined in Docket No. 7602 at a cost of $48,904,000. One of the 138/25 kV 50 MVA transformers for the Kewalo Substation was installed at the Kamoku Substation. The Kamoku Substation site was selected since development of the Keawe Substation was not occurring fast enough. Throughout these projects, no new 46 kV transformers, circuits or improvements were pursued from either of these substations even though they are both centrally located to serve load in the east Oahu area, specifically the Pukele Substation service area.

Q. WHAT CONCLUSIONS DO YOU DRAW REGARDING THESE PROJECTS AND THE RESULTS OBTAINED?

A. HECO ratepayers have paid a considerable amount of money ($86.8 million) to develop two 138 kV substations that now service only 10 MW of load, which is less than 1% of the system load. Installation of the Kewalo improvements and Kamoku 138 kV transmission line made it very practical to provide reliable operation and service to east Oahu customers by improving the 46 kV sub-transmission system, yet 46 kV improvements were not pursued.

Q. DO YOU CONCLUDE THAT THE PUKELE SUBSTATION RELIABILITY CONCERN SUPPORTS HECO'S NEED TO MAKE ELECTRIC SYSTEM IMPROVEMENTS AT THIS TIME?

A. Yes, the Pukele Substation reliability concern fully supports the need to make electric system improvements. Of importance is that the Pukele Substation has been operated in its existing manner since construction (i.e., two 138 kV transmission lines and no backup of load at the 46 kV level). Little has been done by HECO to eliminate the Pukele Substation Reliability Concern, even when opportunities have presented themselves.

D. DOWNTOWN RELIABILITY CONCERN

Q. WHAT ARE HECO'S CONCERNS ABOUT THE RELIABILITY OF THE 138 KV SYSTEM SERVING THE DOWNTOWN SUBSTATIONS?

A. The Archer Substation, Kewalo Substation and Kamoku Substation all have less than three transmission lines feeding the substations. All of these substations are newer substations and are fed from underground 138 kV transmission lines (HECO T-4, pages 46 and 47).

Q. IF BOTH LINES FEEDING THESE THREE SUBSTATIONS ARE OUT OF SERVICE, WILL LOSS OF LOAD OCCUR?

A. Yes, as stated earlier in my testimony, the following loads will be lost during double contingency outages to Archer and Kewalo Substations, and a single contingency outage to Kamoku Substation.

Archer	59.5 MW
Kamoku	5 MW
Kewalo	5 MW

Q. ARE THERE OTHER DOWNTOWN SUBSTATION RELIABILITY CONCERNS?

A. Yes. The Kewalo Substation and Kamoku Substations are both fed from the Archer Substation via 138 kV transmission lines. An outage of Archer Substation also means an outage of both the Kewalo and Kamoku Substations. HECO does not consider an outage of the Archer, Kewalo and

Kamoku Substations to be as critical as an outage of the Pukele Substation, since the 138 kV lines are newer and the amount of load is not as great as the load served by the Pukele Substation (HECO T-4, page 48). My opinion however, is that this reliability concern is greater than HECO has presented.

Q. WHY DO YOU CONTEND THAT THE DOWNTOWN RELIABILITY CONCERN IS GREATER THAN HECO HAS STATED?

A. As pointed out earlier, HECO constructed a 25 kV distribution system serving the Kewalo and Kamoku Substations. Although there is little load (10 MW) on the 25 kV systems at this time, HECO plans to continue to develop this system to serve load in the vicinities of these two substations. Over time as more and more load is added to the 25 kV system, the reliability concern of the system serving the Kewalo and Kamoku Substations will continue to increase. These loads served at 25 kV do not have the potential to be backed up from other area substations via 46 kV sub-transmission circuits or 12 kV distribution circuits.[5] Therefore, the Kamoku 46 kV Underground Alternative – Expanded will not increase the reliability of either the Kewalo or Kamoku Substations since the electrical system serving these substations is at the 25 kV distribution level. While this is not a great concern at this time, it will be come a greater concern as the 25 kV load grows.

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[5] The Consumer Advocate notes that although the Iwilei Substation is able to serve 25 kV loads, it is not connected to the Kewalo or Kamoku Substations.

Although load growth has not been as HECO once projected in the Kakaako district, there are plans for a new University of Hawaii medical facility and other new developments planned for the Kakaako and Kewalo areas that will likely be served from the 25 kV system. Adding this additional load to the 25 kV system increases the concern regarding the reliability of this system since it cannot be backed up from other transmission substations like 46 kV circuits.

Q. DO YOU CONCLUDE THAT THE DOWNTOWN SUBSTATIONS RELIABILITY CONCERN SUPPORTS THE NEED FOR HECO TO MAKE SYSTEM IMPROVEMENTS AT THIS TIME?

A. Yes.

E. SUMMARY OF TRANSMISSION CONSTRAINTS

Q. COULD YOU PLEASE SUMMARIZE YOUR FINDINGS REGARDING THE KOOLAU/PUKELE OVERLOAD SITUATION, THE DOWNTOWN OVERLOAD SITUATION, THE PUKELE RELIABILITY CONCERN AND THE DOWNTOWN RELIABILITY CONCERN?

A. HECO has some valid concerns regarding the overloading and reliability of certain portions of the Oahu electric system. Numerous studies have concluded that the system status quo could lead to overload problems and reliability issues. My findings conclude that there are steps HECO can take to

mitigate the near term Koolau/Pukele overload situation until at least 2012. I also find that the Downtown Overload Situation is not a great concern at this time since it occurs so far into the future. However, retirement of HPP has been brought up numerous times in the Company's testimony and this is a concern. Should the project proposed in the instant docket be implemented and HPP is subsequently retired, additional system improvements may be needed to relieve overloading of the downtown area.

The reliability of the electrical system serving the Pukele Substation is a concern to be addressed and has been for some time. HECO has expressed this concern from 1986 forward in numerous studies and dockets. A concern that parallels the reliability concern of the system serving the Pukele Substation is HECO's lack of action to improve the substation reliability via 46 kV improvements. Construction of the Kewalo and Kamoku Substations make it very practical to obtain additional 46 kV sources for Pukele loads from other transmission substation – a practice which is recommended by HECO sub-transmission planning criteria (HECO response to CA-IR-34, part c, page 3 of 3) and supported by myself. It is difficult to understand why HECO has not previously pursued such projects.

Reliability of the downtown area is not a great concern to HECO, but I find it to be more of a concern. Construction of the 25 kV distribution systems that are fed from the Kewalo and Kamoku Substations cannot be backed up by other transmission substations. Should the system serving the Archer

Substation or the Kewalo Substation be out of service, the 25 kV load served by these substations will be out as well without other sources of backup. As load growth continues on the 25 kV systems, so do reliability concerns.

Q. BASED UPON YOUR CONCLUSIONS AND FINDINGS REGARDING HECO'S OVERLOAD AND RELIABILITY CONCERNS, ARE SYSTEM IMPROVEMENTS NECESSARY AT THIS TIME TO ADDRESS IMMEDIATE NEEDS?

A. Yes, HECO's electric system reliability, specifically the Pukele Substation Reliability and the potential Downtown Reliability issues, are immediate concerns. In the near term, line overloading is not a factor, however, long term system improvements are necessary to avoid future line overloading.

Q. GIVEN THE NUMEROUS ALTERNATIVES PRESENTED BY HECO THROUGHOUT THE DEVELOPMENT OF THE EOTP, WHAT SYSTEM IMPROVEMENTS ARE NECESSARY AT THIS TIME?

A. System improvements that increase the reliability of service to East Oahu customers are of the greatest need at this time and specifically, improvements to address the Pukele and Downtown Substation Reliability Concerns. To determine what identifiable improvements are required, HECO's planning procedures and criteria must be reviewed and applied to determine an efficient solution. The next section of my testimony will review HECO's planning